Case Studies: CHP at Critical Facilities

Western Missouri CHP Summit

David Baker

October 16, 2018

Agenda

- DOE CHP TAP
- Missouri CHP Systems
- Critical Infrastructure
- Case Studies of Resilient CHP Systems
- CHP Project Development Resources
- Next Steps

Missouri CHP Systems

Project Snapshot:

Committing to Zero-Coal and Zero-Waste

Veolia Energy Kansas City Center
Kansas City, MO

Application/Industry: District Energy
Capacity (MW): 5 MW
Prime Mover: Boiler/Steam Turbine
Fuel Type: Biomass
Thermal Use: Steam for Heating Buildings, Hot Water, Heated Coils on Pavement and Sidewalks (~60 customers, 4 million sq. ft.)
Installation Year: 2012

Testimonials: *"District energy systems produce steam, hot water or chilled water at a central plant. In Kansas City, the steam and chilled water is then piped underground to individual buildings for space heating, domestic hot water heating and air conditioning. As a result, individual buildings served by a district energy system do not need their own boilers or furnaces, chillers or air conditioners. The district energy system provides that with the benefits of improved energy efficiency, reduced costs, increased reliability and a reduction in greenhouse gas emissions."*
- Matt DiGeronimo, General Manager of Veolia Energy's Kansas City Facility

"Increasing sustainability in a system that has contributed to Kansas City efficiency since the early 1900s should significantly improve air quality in the city and reduce greenhouse gas emissions in the region."
- Sly James, Mayor of Kansas City, Missouri

Source: http://greenabilitymagazine.com/blog/2016/06/veolia-energy-commits-to-zero-coal-and-zero-waste/

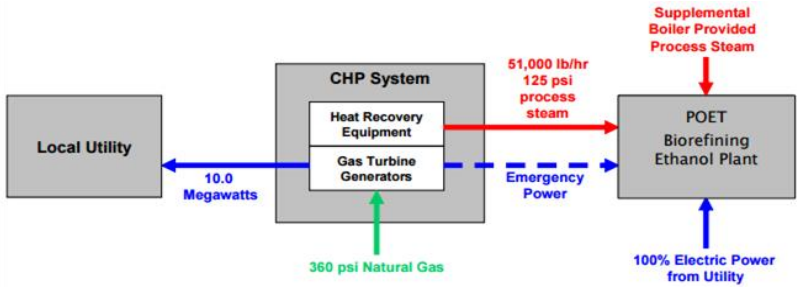
Project Snapshot:

Partnership with an Ethanol Plant

POET Biorefining & City of Macon, Missouri
Macon, MO

Application/Industry: Ethanol Plant
Capacity: 10 MW
Prime Mover: Gas Turbine
Fuel Type: Natural Gas
Thermal Use: Thermal requirements of the ethanol production process
Installation Year: 2003
Energy Savings: 15-25% reduction in natural gas steam producing costs

Highlights: The CHP system at POET provides nearly 60% of the facility's steam requirements, electric power for the plant and local grid. The plant has experienced numerous grid outages since CHP operations began in 2003 and has successfully maintained operation of the plant during these outages by switching the load totally to the CHP system, according to plant General Manager, Steve Murphy.



Source:
http://www.midwestchptap.org/profiles/ProjectProfiles/POETandCityofMacon.pdf

Project Snapshot:
BOOM Project using Landfill Gas

Jefferson City and Algoa Correctional Centers
Jefferson City, MO

Application/Industry: Correctional
Capacity: 3.2 MW
Prime Mover: Reciprocating Engines
Fuel Type: Landfill Gas
Thermal Use: Heating and hot water
Installation Year: 2009

Source: https://jccc.mo.gov/

Highlights: Ameresco built, owns, operates and maintains (often referred to as BOOM) a landfill gas to energy CHP plant next to the Jefferson City Correctional Center (JCCC). In addition to providing steam and hot water to JCCC, excess steam is piped to the nearby Algoa Correctional Center, and the green power is sold to Columbia Water & Light under a 20-year power purchase agreement.

"This project creates a clean, reliable and consistent source of energy from a naturally occurring by-product of our landfills. I commend this innovative partnership for the benefits it will bring our economy, environment and communities." – Jay Nixon, Governor

Source: http://www.ameresco.com/wp-content/uploads/2017/02/jefferson_city.pdf

Critical Infrastructure

CHP & Infrastructure Resiliency

"Critical infrastructure" refers to those assets, systems, and networks that, if incapacitated, would have a substantial negative impact on national security, national economic security, or national public health and safety."

Patriot Act of 2001 Section 1016 (e)

Applications:

- Hospitals and healthcare centers
- Water / wastewater treatment plants
- Police, fire, and public safety
- Centers of refuge (often schools or universities)
- Military/National Security
- Food distribution facilities
- Telecom and data centers

CHP (if properly configured):

- Offers the opportunity to improve Critical Infrastructure (CI) resiliency
- Can continue to operate, providing uninterrupted supply of electricity and heating/cooling to the host facility

Case Studies

Hospitals and Healthcare Facilities

- South Oaks Hospital
- Texas Medical Center
- Gundersen Health System
- Presbyterian Homes

Water / Wastewater Treatment Plants

- Downers Grove Sanitary District

Police, Fire, and Public Safety

- Bridgewater Correctional Complex
- Winnebago County Sheriff's Office

Centers of Refuge (schools, universities)

- Princeton University
- University of Minnesota
- Washtenaw Community College
- Maine South High School
- Bradley International Airport

Military/National Security

- Fort Knox

Data Centers

- University of Toledo Data Center
- First National Bank of Omaha

Hospitals and Healthcare Facilities

Project Snapshot:

Resiliency and Disaster Relief

South Oaks Hospital

Amityville, NY

Application/Industry: Healthcare
Capacity (MW): 1.25 MW
Prime Mover: Reciprocating Engines
Fuel Type: Natural Gas
Thermal Use: Steam, Cooling, Hot Water
Installation Year: 2007

Highlights: After Superstorm Sandy, South Oaks continued to provide critical health services for two weeks relying solely on their CHP system. They admitted patients displaced from other sites, refrigerated vital medicines, and welcomed staff and local community to recharge electronic devices and shower. South Oaks' previous CHP system operated continuously through the Northeast Blackout of 2003 as well.

"Our system… allows us to become a "SHELTER IN PLACE" facility providing all services to our patients and staff and assist the community well beyond the code requirement of 96 hours."
Bob Chester, Director of Engineering

Source:
http://www.northeastchptap.org/Data/Sites/5/documents/profiles/newprofiles/southoaks_case_study_02may13.pdf

Slide prepared 2016

CHP Technical Assistance Partnerships
CENTRAL

CHP Project Snapshot:

Resilient Healthcare

Texas Medical Center and TECO
Houston, TX

Application/Industry: Hospitals
Capacity: 48 MW
Prime Mover: Gas Turbine
Fuel Type: Natural Gas
Thermal Use: Steam-driven chillers, space heating, hot water, dehumidification, and sterilization
Installation Year: 2010

Highlights: While Houston and surrounding areas were faced with uncertainty as Hurricane Harvey made landfall, the Texas Medical Center – the largest medical center in the world – was able to sustain its air conditioning, refrigeration, heating, sterilization, laundry, and hot water needs throughout the storm thanks to CHP. Although the CHP system was designed primarily to increase energy efficiency and reduce energy costs for the medical center, the events of Hurricane Harvey showed that CHP was a crucial part of emergency preparedness and helped staff focus on patient care without fear of losing power.

"The customers we serve, hospitals and medical research facilities, have critical loads. Reliability is extremely important to them, and CHP is an important factor in ensuring excellent reliability. "
- Steve Swinson, TECO President

http://www.southwestchptap.org/data/sites/1/documents/profiles/Texas_Medical_Center-Project_Profile.pdf

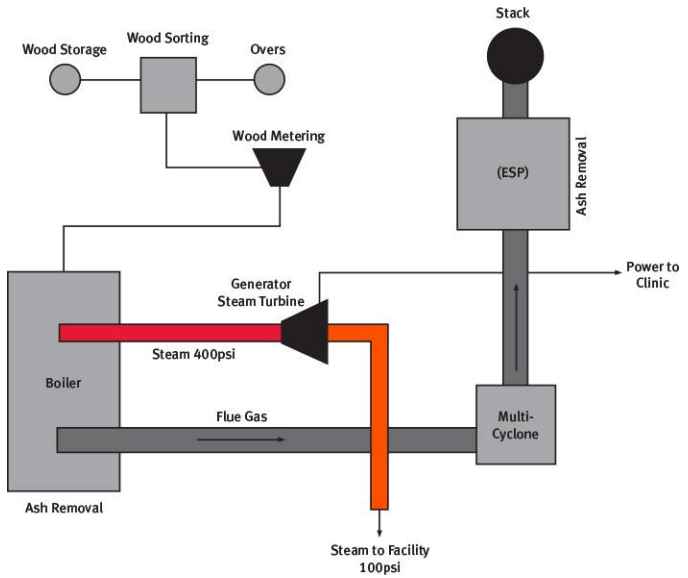
Project Snapshot:
100% Energy Independence

GUNDERSEN HEALTH SYSTEM®

Gundersen Health System
La Crosse, WI

Application/Industry: Hospital
Capacity: 500 kW
Prime Mover: Boiler/steam turbine
Fuel Type: Biomass
Thermal Use: Heating, hot water, sterilization
Installation Year: 2013
Energy Savings: $500,000/year

Highlights: Gundersen Health System received a $225,000 grant from the U.S. Forest Service through the Wisconsin Department of Administration for the biomass CHP system at their La Crosse campus. Gundersen Health system reached 100% energy independence in 2014 thanks to their 4 CHP systems at their campuses.



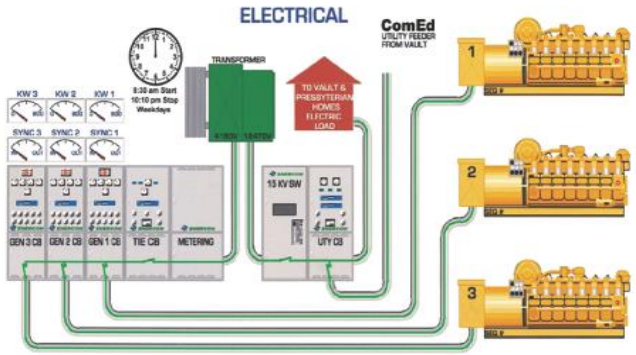
Source: http://www.gundersenhealth.org/news/gundersen-powers-up-biomass-boiler, http://lacrossetribune.com/news/local/gundersen-s-new-wood-chip-boiler-taps-region-s-resources/article_79024da6-b2c7-11e2-8d3a-0019bb2963f4.html

Project Snapshot:
Energy Security

Presbyterian Homes
Evanston, IL

Application/Industry: Nursing Home
Capacity: 2.4 MW
Prime Mover: Reciprocating Engines
Fuel Type: Natural gas
Thermal Use: Building heat and domestic hot water
Installation Year: 2001

Highlights: An ice storm in the winter of 1998 knocked out power for 9 hours. 600 senior residents were transferred to safety during this time. CHP was installed to avoid future outages.



"The environment we provide to elderly adults had everything to do with our decision to pursue power generation. Loss of power isn't an option. Lives depend on it."
- Keith Stohlgren, V/P Operations

"We had no power for nine hours one cold, winter day during an ice storm. The loss of power forced us to take immediate, aggressive measures to ensure the comfort and safety of our residents."
– Nancy Heald Tolan, Director of Facilities Management

Centers of Refuge (schools, universities)

Project Snapshot:
District Energy with CHP

Princeton University
Princeton, NJ

Application/Industry: University
Capacity (MW): 15 MW
Prime Mover: Gas Turbine
Fuel Type: Bio-diesel & Natural Gas
Thermal Use: Steam, Chilled Water
Installation Year: 1996

Highlights: Princeton has a 15 MW district energy system with CHP that provides electricity, steam, and chilled water across campus. It supports 150 buildings, including residential and academic buildings, athletic facilities and dining halls. During Superstorm Sandy, the University disconnected from the grid and supplied 100% of campus energy needs for three days until grid power was restored. The CHP plant was vital to maintaining important university facilities such as research labs, experiments and data that could have been compromised by a loss of power.

https://www.energy.gov/sites/prod/files/2013/11/f4/chp_critical_facilities.pdf

"What even fewer people considered was that there was no interruption to steam or chilled water service since all distribution is underground. Yet another reason for district energy!"

- Edward T. Borer Jr., Manager of the Energy Plant

Project Snapshot:

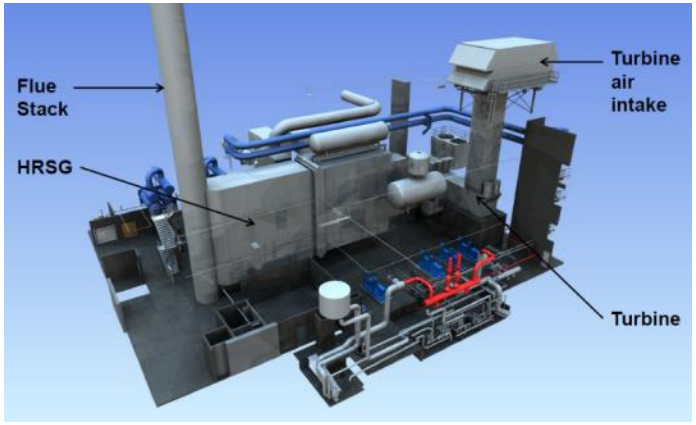
Energy Security

University of Minnesota
Minneapolis, MN

Application/Industry: University Campus
Capacity: 25 MW
Prime Mover: Combustion turbine
Fuel Type: Natural gas
Thermal Use: Steam, heating, cooling
Installation Year: 2017

Highlights: The CHP system decreases the Twin Cities Campus carbon footprint by 15% and provides an 8-year return on investment. The 25 MW system heats the entire campus and meets half of its electricity demand.

Testimonial: *"We see CHP as a way to be competitive with other schools and to protect research if we had a catastrophy."*
- Jerome Malmquist, University Director of Energy Management



Rendering of turbine and heat recovery steam generator.


Minimal changes will need to be made to the existing building's exterior.

Source: http://www1.umn.edu/regents//docket/2012/february/heatandpower.pdf
http://midwestenergynews.com/2014/12/02/university-turns-to-combined-heat-and-power-for-climate-goals/

Project Snapshot:

Interactive CHP System

Washtenaw Community College

Ann Arbor, MI

Application/Industry: College
Capacity (MW): 130 kW
Prime Mover: Microturbine
Fuel Type: Natural Gas
Thermal Use: Hot Water, Cooling
Installation Year: 2014
Energy Savings: >$60,000/year

Highlights: The microturbine CHP system at Washtenaw Community College is equipped with a FlexSet control system. The web-based system allows facility managers to monitor the system on computers or cell phones. The system's designer, GEM Energy, also donated an additional microturbine to the school for the training of future energy professionals.

Source: http://www.gemenergy.com/wp-content/uploads/2014/10/CHP-Washtenaw-102814.pdf

Slide prepared 2016

Project Snapshot:

Resilient High School

Maine South High School
Park Ridge, Illinois

Application/Industry: High School
Capacity: 1,600 kW
Prime Mover: Reciprocating Engines
Fuel Type: Natural Gas
Thermal Use: Heating, cooling, hot water (previously)
Installation Year: 1992

Highlights: In the year preceding CHP installation, the school experienced 13 extended electric outages, costing the school district $170,000 per day in operating expenses for a single 30-minute outage. In 2007 during a violent rain storm that forced 630,000 ComEd customers to lose power, the school disengaged from the grid, operated its CHP system, and maintained building operation throughout the weather event. The two 800 kW Caterpillar engines have full black start capability, using a battery to start the engines if grid electricity in not available.

Source:
http://www.midwestchptap.org/

Project Snapshot:

Energy Secure Airport

Bradley International Airport

Hartford County, CT

Application/Industry: Airport

Capacity: 5.8 MW

Prime Mover: Reciprocating Engines

Fuel Type: Natural Gas

Thermal Use: Heating, cooling, and hot water

Installation Year: 2002, 2010

2 MW Gas Engine-Generator installed in 2010

Highlights: Bradley International Airport near Hartford, CT installed CHP in 2002 and added to it in 2010, motivated primarily by the need to increase energy security, after several recent outages disrupted air service. The system provides heating, hot water, and cooling through an absorption chiller to the airport terminals and can continue to provide electricity during a grid outage, operating in island mode. The system also provides substantial operating cost savings when compared to a conventional central heating/cooling plant.

Source: http://www.northeastchptap.org/Data/Sites/5/documents/profiles/BradleyAirportpp.pdf/

Police, Fire, and Public Safety

Project Snapshot:

2009 EPA ENERGY STAR CHP AWARD

Bridgewater Correctional Complex
Bridgewater, MA

Source: www.mass.gov

Application/Industry: Correctional
Capacity: 1,500 kW
Prime Mover: Combustion Turbine
Fuel Type: Natural Gas
Thermal Use: Heating, cooking, cleaning, domestic hot water
Installation Year: 2006

Source: www.dmiinc.com

Highlights: The correctional complex consists of 785,000 square feet of living and working space on 14,900 acres. The CHP system generates ~80% of the electric demand. Operation of the CHP system allowed the Massachusetts Department of Correction to shut down an old and more-polluting diesel engine generator. With an operating efficiency of approximately 67%, the CHP system requires approximately 17% less fuel than typical onsite thermal generation and purchased electricity.

Source: www.epa.gov/CHP/energy-star-CHP-awards

Project Snapshot:

Targeting Net-Zero

Winnebago County Sheriff's Office
Oshkosh, WI

Application/Industry: Public Safety
Capacity (MW): 2.5 MW
Prime Mover: Reciprocating Engines
Fuel Type: Landfill Gas
Thermal Use: Heating, Cooling and Hot Water
Installation Year: 2007, 2009

Highlights: In 2007 Winnebago County Solid Waste Management Board began operating a 1.1 MW CHP system burning landfill gas, providing heat and hot water to the new Sheriff's Office buildings, and selling excess power to Wisconsin Public Service. In 2009 the county added 1.4 MW of electric capacity along with a 250 ton absorption chiller to provide cooling. The Sheriff's Office saves nearly $1 million annually in natural gas costs alone.

"This is an extremely efficient use of our landfill gas. The county is glad to hear that we are creating revenue and saving money in heating costs." – Jim Morris, Landfill Manager for Winnebago County Gas Recovery

Source:
http://www.midwestchptap.org/profiles/ProjectProfiles/Winnebago_County_Sheriffs_Office.pdf

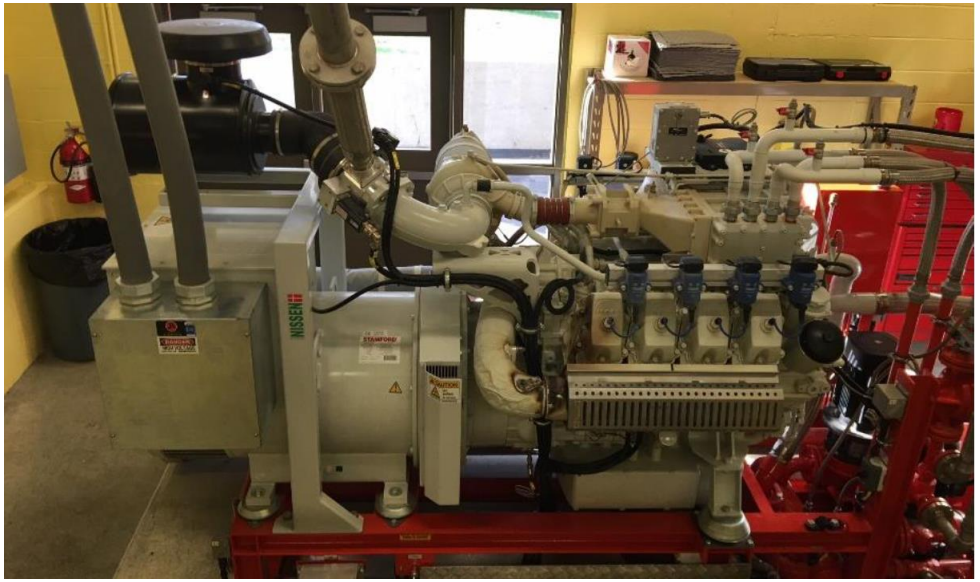
Water / Wastewater Treatment Plants

Project Snapshot:

Targeting Net-Zero

Downers Grove Sanitary District
Downers Grove, IL

Application/Industry:
Wastewater Treatment
Capacity (MW): 655 kW
Prime Mover: Reciprocating Engines
Fuel Type: Biomass
Thermal Use: Heat for Digestion Process
Installation Year: 2014, 2017



Highlights: In 2014, DGSG installed a 280 kW engine-driven generator with heat recovery, along with a gas conditioning system. The plant began processing waste grease from nearby restaurants within the digester system to increase gas production. To fully utilize this resource, it installed an additional 375 kW engine and generator in 2017 with incentives from utility ratepayer Energy Efficiency Portfolio Funds.

Source:
http://www.midwestchptap.org/profiles/ProjectProfiles/DownersGrove.pdf

Military/National Security

Project Snapshot:

Energy Security Microgrid at Army Base

Fort Knox
Fort Knox, KY

Application/Industry: Military
Capacity (MW): 8.2 MW
Prime Mover: Reciprocating Engines
Fuel Type: Natural Gas
Thermal Use: Steam, Hot Water, Chilled Water
Installation Year: 2014

Highlights: In 2009, Ft. Knox Army Base was hit by a major ice storm causing it to lose its connection to the local utility for as long as 10 days. Fort Knox then partnered with Nolin Rural Electric Cooperative to develop an energy security microgrid comprised of 8 MW of CHP natural gas generators, 16 MW of peak-shaving natural gas generators, and 20 MW of diesel backup. The CHP generators are deployed at three different sites on post, chosen for being critical infrastructure and prime locations for the thermal load produced by the CHP systems – the army hospital, the data center, and the postal exchange.

Source:
http://www.southeastchptap.org/Data/Sites/4/documents/profiles/fort-knox-chp_project_profile.pdf

Data Centers

Project Snapshot:

Data Center Reliability

University of Toledo Data Center
Toledo, OH

Application/Industry: Data Center
Capacity: 260 kW
Prime Mover: Microturbines
Fuel Type: Natural Gas
Thermal Use: 1.0 MMBtu/hr Hot Water and 100 tons Chilled Water
Installation Year: 2013

Testimonial: The University of Toledo (UT) and GEM Energy partnered on the design and development of a modular power system to significantly reduce energy consumption and increase electric reliability at the campus data center. At the time of 2013 commissioning, UT's completed modular unit was the second data center in the nation and the first in Ohio to use micro turbines for heating, cooling and non-interruptible power.

Source: http://gemenergycapstone.com/

Project Snapshot:

Data Center CHP with 99.9999% Reliability

First National Bank Omaha

First National Bank of Omaha
Omaha, NE

Application/Industry: Computing Facility/ Data Center
Capacity: 400 kW
Prime Mover: Fuel Cells
Fuel Type: Natural Gas
Thermal Use: heating, snow melting, dehumidification
Installation Year: 2013
Energy Savings: Unknown

Testimonial: *"We have had a great experience with the reliability afforded our data center operations since installing our first fuel cells in 1999".*
- Brenda Dooley, President, First National Buildings, Inc.

Source:
http://www.midwestchptap.org/profiles/ProjectProfiles/FirstNationalBank.pdf

Summary and Next Steps

- CHP is a proven technology providing energy savings, reduced costs, and opportunities for resiliency
- There are many examples of critical infrastructure with resilient energy systems anchored by CHP
- Resources are available to assist in developing CHP Projects
- Contact the US DOE CHP TAP:
  - To receive a complementary CHP qualification screening or other technical assistance.
  - If you already have an existing CHP plant and interested in expanding it
  - Need an unbiased 3rd Party Review of a proposal
  - Interested in further information on best practice state policies for CHP to support energy resilience, including through a webinar or face-to-face meeting

Thank You

Cliff Haefke
Director
(312) 355-3476
chaefk1@uic.edu

David Baker
Assistant Director
(312) 996-2615
dsbaker@uic.edu

Energy Resources Center
University of Illinois at Chicago

CHP Technical Assistance Partnerships
CENTRAL

www.energy.gov/chp